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A SHAFT TO TRANSFER TORQUE IN A VEHICLE

TECHNICAL FIELD

[0001] This invention relates generally to the automotive field, and more specifically to an improved shaft to transfer torque between an engine and a wheel of a vehicle.

BACKGROUND

[0002] In a typical front-wheel-drive based vehicle with all-wheel-drive capabilities, the rear wheels are coupled to a rear differential through a complex arrangement of two plunging constant velocity joints and a half shaft. The half shaft allows for the transfer of torque, while the two plunging constant velocity joints allow for both the vertical movement of the wheel and the relative change in distance between the wheel and the differential. The problem with this arrangement is the cost and weight of the plunging constant velocity joints, which total approximately 75% of the half shaft assembly. Thus, there is a need in the automotive field to create an improved shaft to transfer torque between the engine and the wheels of a vehicle with reduced cost and weight.

BRIEF DESCRIPTION OF THE FIGURES

[0003] FIGURE 1 is an unassembled perspective view of a shaft made in accordance with the teachings of the preferred embodiment of the invention;

[0004] FIGURE 2 is a side view of the shaft taken along view line 2--2;

[0005] FIGURE 3 is a fragmented perspective view of the portion of the shaft shown in FIGURE 2, which illustrates the internal splines formed upon the shaft of the preferred embodiment of the invention; and

[0006] FIGURE 4 is a side view of the shaft with a biasing device according to the teachings of the preferred embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0007] The following description of the preferred embodiments of the invention is not intended to limit the invention to these preferred embodiments, but rather to enable any person skilled in the automotive field to make and use this invention.

[0008] As shown in FIGURES 1 and 2, the shaft 10 of the preferred embodiment includes a first member 11 having internal splines 12 (shown in FIGURE 2) and a second member 13 having external splines 14. The external splines 14 are engagable with the internal splines 12 to allow telescopic movement between the first member 11 and the second member 13 and to transfer torque between the first member 11 and the second member 13. The external splines 14 have a coating 15 to reduce friction during the telescopic movement.

[0009] As shown in FIGURE 4, the shaft 10 of the preferred embodiment is used in a vehicle to transfer torque between the engine (not shown) and a wheel 17 of the vehicle and, more specifically, to transfer torque between a power distribution device 18 and the "auxiliary wheels" of an all-wheel-drive vehicle. In a front-wheel-drive based all-wheel-drive vehicle, the "auxiliary wheels" are the rears wheels, while in a rear-wheel-drive based all-wheel-drive vehicle, the "auxiliary wheels" are the front wheels. In these vehicles, the power distribution device 18 is preferably a

conventional differential device. In this environment, the shaft 10 acts as a half shaft 19 and is preferably coupled with the power distribution device 18 with a first cardan universal joint 20 and is preferably coupled with the wheel 17 with a second cardan universal joint 21. The shaft 10, of course, could be alternatively coupled with other suitable devices and could be used in other suitable environments, such as between the engine and the differential (acting as a "driveshaft" or "propshaft"), to transfer torque across a particular distance.

[00010] The preferred embodiment also includes a biasing device 22 connected to the shaft 10. The biasing device 22, which functions to support the vehicle on the wheel 17 and to absorb road imperfections, may include a conventional coil spring and damper combination, a leaf-spring and damper combination, an active suspension unit, or any other suitable biasing device. The half shaft 19 is preferably attached to the biasing device 22 with a conventional joint 23, but may alternatively be attached with any suitable device.

[00011] As shown in FIGURES 1 and 2, the first member 11 and the second member 13 of the preferred embodiment are round, tubular, and generally hollow. The internal splines 12 are preferably circumferentially formed upon an internal surface 24 of the first member 11, while the external splines 14 are preferably circumferentially formed upon an external surface 25 of the second member 13. In the preferred embodiment, the first member 11 and the second member 13 are substantially steel. In alternative embodiments, the first member 11 and the second member 13 are preferably any sufficiently strong material, such as aluminum, magnesium, or a composite material, to transfer torque between the engine and the wheel of the vehicle without substantial deformation.

[00012] As shown in FIGURES 2 and 3, the internal splines 12 of the preferred embodiment allow for relatively wide mating surfaces (or "working areas"). In the preferred embodiment, the internal splines 12 have a pitch diameter 26 equal to about 25 to about 100 millimeters. These splines allow for better distribution of the axial loads imparted upon the first member and the second member to reduce the overall wear of the internal splines 12 and the working or operating life of the shaft. In the preferred embodiment, each end wall 27 of each spline cooperatively forms an angle 28 of about sixty degrees (60°), although other angular configurations may be used. Further, while a portion of only the internal splines 12 of the first member 11 are shown in FIGURE 3, it should be realized that the external splines are substantially similar.

[00013] The second member 13 is adapted to telescopically penetrate the first member 11 during the suspension movement of the wheel and to allow the internal splines 12 and the external splines 14 to cooperatively intermesh. As shown in FIGURE 1, the coating 15 on the external splines 14 functions to reduce friction during the telescopic movement of the first member 11 and the second member 13. In the preferred embodiment, the coating 15 is tungsten disulfide, sold under the tradename MicroBlue® by Material Technologies, Inc. The MicroBlue® coating 15 is preferably applied with a thickness less than about 10 microns. In an alternative embodiment, the coating 15 is preferably a nylon material, sold under the tradename Nylon 66 by E.I. du Pont de Nemours and Company. Further, in the preferred embodiment, the external splines 14 also have an isotropic surface finish, as described in US 5,503,481 entitled "Bearing Surfaces with Isotropic Finish", issued on 02 April 1996, and incorporated in its entirety by this reference. The tungsten

disulfide coating over an isotropic surface finish significantly reduces the friction between the first member and the second member, while increasing the wear and durability of the shaft. In alternative embodiments, any suitable coating 15 that reduces the friction to a sufficient level may be used on the external splines 14 of the second member 13.

[00014] The shaft 10 of the preferred embodiment also includes a substantially round and generally tubular shaped vibration-dampening member 29. The vibration-dampening member 29 functions to absorbs at least some of the vibrational energy generated by the first member 11 and the second member 13 during the transfer of torque between the engine and the wheel and during the suspension movement of the wheel. The vibration-dampening member 29 is preferably adapted to conform to the shape of the first member 11 and the second member 13 and is preferably removably and selectively placed within the assembled first member 11 and the second member 13. The vibration-dampening member 29 is preferably formed conventional and commercially available cardboard, but may alternatively be formed from a variety of other vibration dampening materials.

[00015] As any person skilled in the automotive filed will recognize from the previous detailed description and from the figures and claims, modifications and changes can be made to the preferred embodiments of the invention without departing from the scope of this invention defined in the following claims.